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EXPERIMENTS ON THE PRODUCTION OF AN IMITATION OF SEA SICKNESS, BY COMPLEX VISUAL DISTURBANCES.

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THE subject of sea sickness has at various times occupied my attention. Personal experience of the Channel passage on many occasions has furnished me with facts bearing on the question as to the cause of sea sickness; and some time ago these facts had led me to the conclusion that in my own individual case the attack of sea sickness—otherwise inevitable in rough weather—could be prevented in two ways: (1) by fixing the eyes on some object away from the vessel, or (2) by completely and continuously closing the eyes and thus for the time abolishing the exercise of the sense of vision.

While staying at a house in the country I was one day using a large glass wardrobe-door mirror. While brushing the hair sensations were perceived like those of on-coming sea sickness. The cause was not immediately apparent, but I soon observed that the wardrobe door, which was delicately hung, was slightly moving all the time, and the movement of the mirror was evidently the cause of the incipient qualmy sensation I had experienced. This observation induced me to make experiments by the aid of a mirror in order to determine more precisely the effect of visual impression disturbances in the production of sea sickness.

I first employed a large mirror, 6 feet by $4\frac{1}{2}$ feet, suspended in a frame so that the mirror could be easily moved in any required direction, the observer seated in a chair 5 feet from the mirror. It was found that in some of the cases experimented on a feeling of giddiness ensued when the mirror, being hung at its centre, was oscillated from side to side for a quarter of an hour. The same effect resulted from fixing the mirror at the two sides, leaving it free to be oscillated at the top and bottom of the mirror. Shortly afterwards a more effective oscillation was found to be produced by suspending the mirror by cords fixed at two opposite oblique corners of the mirror, so that the mirror could be oscillated on its oblique axis. Giddiness was the principal effect produced by the oscillations in the cases tried. It is to be noted that the carpenter who erected the frame for suspending the

mirror, and his assistant, voluntarily stated that while hanging the mirror they "felt queer at the stomach," they being not in the least aware of the object for which the apparatus was erected. The carpenters were, of course, moving about in front of the mirror when they experienced these sensations.

It next occurred to me to place the subject experimented on in a swing opposite the oscillating mirror, and thus more completely to imitate the condition of things encountered at sea by moving the body of the individual as well as the mirror. I accordingly arranged in front of the mirror a swinging platform on which the subject of the experiment was made to sit, this swing being movable in any direction required, and admitting of a vertical motion, the ropes running over pulleys and the weight of the individual properly compensated by weights at the ends of the ropes. I thus contemplated the production, by means of the apparatus, of very complex disturbances of visual impressions.

Observations were made with the apparatus erected for the purpose in the Pene Library at University College, which room was kindly lent to me for a short time by the Council in January, 1880. After having made several experiments, it was necessary to remove the apparatus, the room being required, and no further experiments were made until five years later, in 1885, when a more complete and easily working apparatus was erected, by the permission of Professor Berkeley Hill, in the bandaging room of University College.

The apparatus employed consisted of a mirror, 6 feet by 4 feet 8 inches, hung almost vertically by cords attached at the upper right-hand and the lower left-hand corner. The mirror thus allowed of being oscillated on its oblique axis by means of a small cord attached to the lower right-hand corner. The mirror was hung with the bottom about 1 foot from the ground. The frame and edges of the mirror were hidden by a curtain of a dark material, and the curtain was further so arranged that the individual seated in the swing was unable to see the sides of the room or any fixed object.

The swinging platform measured 4 feet by 2 feet, was provided with a seat, and, as already stated, suspended by ropes passing over pulleys. Two assistants—one on each side of the swing—were employed to move the swing in the required directions. The weight of the subject of the experiment being properly compensated, it is thus possible to move the platform up and down, from side to side or backwards and forwards, or to combine certain of these motions as may be required. The swing platform was so placed that when seated in it the subject was about 5 feet from the mirror, and the face corresponded with its centre.

OBSERVATION 1 (January 17th, 1880) with the apparatus properly arranged for the first time in the Pene Library, University College. Mr. W., my clinical clerk at the hospital, was the subject of the experiment. He was in full health. The platform was swung gently from side to side about 6 inches on each side, giving a movement of 1 foot altogether. It was at the same time lowered and raised alternately about 6 or 8 inches at the two ends alternately. Sometimes the movement was varied by making the movement obliquely from opposite corners of the swinging platform. While the individual experimented on was moved in this way the mirror was also made to move in the oblique manner before described. It was made to move obliquely by pulling a cord attached to the right hand lower corner forwards about 6 or 8 inches, and allowing it to move back again by loosening the cord. An oscillation was thus produced, and this oscillation was so timed as to correspond with the movement of the swinging platform. The swinging movements were made at the rate of

from sixteen to twenty in the minute. The observation lasted ten minutes. During the first part of this time the movements of the swing and of the mirror were not accurately synchronous, but during about five minutes they were made tolerably well together. Towards the close of the observation the individual in the swing felt uncomfortable and ill, the feeling became finally so intensified that he declined to remain any longer in it, and declared that he could no longer do so in consequence of the severe feeling of nausea and illness present. He had now become very white at the lips, and the bystanders considered that his condition was to all intents and purposes identical with that of a person at sea who is on the point of becoming violently sick. The feeling of illness remained for some minutes after he had removed from the swing. The gentleman experimented on states that he is not usually made seasick until he has been on the vessel some time, but when the motion of the vessel is considerable he becomes ill.

OBSERVATION II (January, 1880).—The second observation was a very limited one, the subject being a youth 15½ years old, very susceptible to sea sickness. On a former occasion, before the apparatus had been quite in order, we had experimented with him, and although the movements of the swing were then only imperfectly produced he then after a quarter of an hour declared he felt he was going to be ill, and declined to go on with the experiment. To-day he got into the swing for about a minute, but positively declined to remain longer, as he so decidedly felt the sensation of illness coming on.

OBSERVATION III (January, 1880).—The subject of this third observation was a young lady of 16 years of age. She is ordinarily not affected by sea sickness until after the lapse of some time. The effects of the experiment were that after a quarter of an hour's trial a sensation of giddiness was produced.

OBSERVATION IV.—The subject of the fourth observation on January 19th was a gentleman, 25 years of age, the obstetric assistant at University College Hospital. After a few minutes in the swing he became affected with the usual sea sick sensation, and it was with difficulty that he was prevailed to remain in it as long as ten minutes. After leaving it he remained uncomfortable and ill for some considerable time, and was unable to eat his dinner. He stated that his sensations were in every way identical with those he had felt before at sea. He is rather easily made ill on a sea voyage.

OBSERVATION V (January 27th, 1880).—Mr. W., who was the subject of the first observation, and who on that occasion was made ill in ten minutes, was to-day experimented upon again. But to-day he was placed in the swing with his eyes blindfolded. He was then subjected to the same movements and for the same time precisely as at the first experiment. He experienced no unpleasant sensation whatever to-day; on the contrary, he enjoyed the movement, and felt rather inclined to sleep. On stepping out of the swing and uncovering the eyes he stated that he felt quite well in every sense of the word, and only a little dazzled by the first impressions of light on the eyes after the ten minutes' darkness.

OBSERVATION VI (January 27th, 1880).—The subject of the experiment was Mr. S., a student of University College Hospital, aged about 22. Mr. S. states that he has only been at sea four times, that on each occasion he was sick, but the sickness only came on after being at sea some time, and was not of a distressing nature. He was to-day subjected to the oblique and up and down movements in the swing, the mirror being moved as in former experiments. He remained in the swing ten minutes. The result was almost precisely identical with that observed in former cases. At the end of ten minutes he expressed a wish to discontinue the experiment, as he felt he was going to be sick, and had a rising sensation in the throat, together with an undue quantity of mucous secretion in the throat. On removing from the swing he stated that the effect produced was in all respects like that which he had felt at sea.

OBSERVATION VII (January 28th).—The subject was a young married lady, 25 years of age. She is not very susceptible of sea sickness, and even when the weather is rough she remains comfortable for some little time, finally however succumbing to the evil influence. She has, however, crossed the Channel feeling quite well, even under rather unfavourable circumstances, when following the directions which I had given her. To-day she was placed in the swing, and subjected for seven minutes to the influence of the motion and disturbed vision. The day was very dark and foggy, and the experiment took place late in the afternoon. At the end of the seven minutes she wished to leave the swing, as she had begun to feel symptoms of discomfort and illness.

OBSERVATION VIII (same day, January 28th).—Subject a lady, about 30 years of age, who states that she is soon made sick at sea. This experiment immediately followed the preceding one, and it had become so very dark that it was not satisfactory. The experiment was continued for twelve minutes. Towards the end of ten minutes a feeling of giddiness

and indisposition was complained of, but these symptoms became a little relieved as the time went on, and, in fact, as the light diminished. The room had become very dark, and the atmosphere obscured by fog.

OBSERVATION IX (January 29th. Present, Dr. Menzies, of Stamford Street.)—The observation to-day was made on Mr. T., one of my clinical clerks at the hospital. He has crossed the Channel two or three times, and has always suffered from sea sickness. He was subjected to the action of the swing and moving mirror combined as in former experiments. No effect seemed to be produced for about a quarter of an hour, but after that time he soon began to feel uncomfortable, and left the swing at the end of twenty minutes feeling decidedly ill, and as he had formerly felt at sea.

OBSERVATION X (January 30th).—A lady, about 35 years of age, unmarried, was the subject of the experiment. She suffers much from sickness when at sea, and has sometimes felt ill on a river. But she does not usually perceive the feeling of sickness until about twenty minutes have elapsed. For the first five minutes she was in the swing she stated that the motion was rather pleasant than otherwise, and she rather enjoyed it. At the end of eight minutes she began to feel a little uncomfortable. The motion of the swing at first was made obliquely from side to side, together with some 6 inches of up-and-down motion, so that the seat of the swing described an ovoid in a vertical plane. The motion was then changed to that of an ovoid in a horizontal plane from side to side. Three minutes after this change had been made, and eleven minutes from the commencement of the experiment, she said that she felt very ill, and left the swing. Shortly after leaving the swing she wished to go out into the fresh air, and immediately after leaving the room she became sick and vomited. A few minutes later she returned to the room looking very pale and ill, and declined to stand even looking at the mirror, though it was in a state of rest.

[Professor Burdon Sanderson to-day inspected the apparatus and saw the lady who had been experimented on.]

Experiments resumed in 1885, simultaneous oscillations of swing and mirror being employed as in first series of experiments.

March 9th, 1885. Two experiments in Bandaging Room, University College, with a somewhat improved apparatus just erected; the movements of the swing not very well managed, and mirror imperfectly oscillated.

OBSERVATION XI.—Mr. Y., one of the clinical clerks at the hospital, not liable to sea sickness. Has never been sick at sea, but has sometimes felt a little inclined to be sick. After being moved in a vertical ovoid plane for about fifteen minutes experiment given up. Produced a slight constriction in throat something like what he had felt at sea.

OBSERVATION XII.—Mr. W., obstetric assistant at University College Hospital; is always ill at sea if at all rough; fifteen minutes' trial. Towards end of time he felt qualmish, but not distinctly nauseated. About two minutes after getting out of the swing he expressed himself as feeling very uncomfortable, with distinct sensations such as he had been accustomed to experience at sea, and had headache in evening.

OBSERVATION XIII (March 11th, 1885).—Mr. T., suffers much from sea sickness. After being in swing ten minutes felt sensations like those of sea sickness and discomfort. Motion of swing chiefly vertical plane ovoid. Duration, fifteen minutes.

OBSERVATION XIV (March 11th, 1885).—Mr. W., moderately good sailor. Duration, fifteen minutes. After seven or eight minutes felt dryness of throat, headache, and nausea. This persisted till he left the swing. Part of time simple horizontal movement of swing found less effective than vertical ovoid.

OBSERVATION XV.—March 11th, 1885. Mr. W. (same as Observation XII on March 9th). In swing 15 minutes. Felt a sharp headache while in swing, but not nauseated as on former occasion.

OBSERVATION XVI.—Mr. V., fairly good sailor. Not much affected, but when he kept his eyes on one object reflected in the mirror he observed that there was commencing discomfort. Duration of experiment, 15 minutes.

OBSERVATION XVII.—Mr. J., good sailor. In swing 10 minutes. No perceptible effect.

OBSERVATION XVIII.—March 12th, 1885. Mr. K., a bad sailor. In swing 8 minutes. Effects, giddiness, fullness in head like what he is accustomed to feel at sea, and sensations of illness, so much so that he was anxious to discontinue the experiment. The last two minutes, horizontal movement from side to side (of swing); these produced more discomfort than the vertical ovoid movement. The mirror was worked to-day more perfectly than in former Experiments XI to XVII.

OBSERVATION XIX.—March 12th, 1885. Mr. G., easily made sick at sea. In swing 5 minutes. Says he is made to feel ill by sitting back to engine in a train. Felt distinctly nauseated in the swing very quickly. The horizontal side to side motion of swing most trying to him.

OBSERVATION XX.—March 20th, 1885. Mr. B., a good sailor, has been

some long voyages, has been only twice seasick when in very large ships and when the vessel pitched with a range of over 25 feet at the bows. The combined swing and mirror movement produced no nauseating effect during nearly 10 minutes' trial.

OBSERVATION XXI.—March 20th, 1885. Mr. —, a very good sailor. No discomfort from 10 minutes' trial.

OBSERVATION XXII.—March 20th, 1885. Mr. W., a very bad sailor; suffers much from sea sickness, and avoids going to sea for this reason. Used to suffer from the motion of swinging when a youth, also sitting with his back to the horses in a carriage is unpleasant to him. To-day he stated that merely looking in the oscillating mirror made him feel uncomfortable, the head beginning to ache, and it was with difficulty he was persuaded to sit in the swing on the promise that he should only be subjected to the mirror disturbance. After sitting looking at the moving (obliquely) mirror 3 minutes, he felt headache and an increased flow of saliva, and begged to be released from further trial, as he felt he should be made really ill.

The effects produced in individuals subjected to the experiments which have been described may be summed up as follows:

In those who were "good sailors," and not in the habit of suffering from sea sickness, there were no particular effects observed. In those who were in the habit of suffering from sea sickness marked discomfort was produced within ten minutes or a quarter of an hour, during which the swing and the mirror were both in motion.

The first discomfort felt was, in some cases, giddiness; in some a fulness in the head, in some headache, these discomforts being quickly followed by a rising in the throat, a catching in the throat, a feeling of sickness, or sensation of nausea more or less pronounced. The exact effect differed in different cases, but the effects appeared to be always recognised as the initial symptoms of sea sickness by the individual experimented upon. The rapidity with which these symptoms were produced varied; those who were most liable to sea sickness were soon affected by the combined swing and mirror action. Two or three minutes sufficed in some cases to produce an unmistakable illness, and desire to discontinue the experiment. In some cases the mirror disturbance alone, and unassisted by the swing action, was sufficient to induce sensations like those of sea sickness.

The motions which most quickly succeeded in producing a feeling of illness were, in the large number of cases, oblique oscillation of the mirror associated with movement of the swing in an ovoid described in a vertical plane. In some cases the horizontal motion of the swing along with the oblique mirror oscillation was most disturbing. It seems evident that the effect produced is, as a rule, in direct proportion to the complexity of the visual disturbances.

In the endeavour to analyse the effect of the associated swing and mirror disturbances, it may be well to advert to the effects produced by swing action alone. It is well known that in some cases the act of swinging produces a feeling of nausea. This was alluded to by Dr. Wollaston in his Croonian Lecture on sea sickness, delivered before the Royal Society in 1810. It appears that the downward motion of the swing produces the effect in the most marked manner. A fellow professor at University College informs me that when a boy he was very fond of swinging, and that it always made him feel sick unless he closed his eyes in the act of descending. This would seem to show that the motion of the body alone was not the cause of the sickness. In the experiments above described, the swing action was made up in part

of a downward and upward motion in conjunction with mirror oscillation, but in some the horizontal movement of the swing was found even more effectual than the vertical action in producing a feeling of illness. Similarly, individuals subjected to vertical motion in the swing without associated mirror action were unaffected.

It must therefore be concluded that when the individual is subjected to the swing *plus* the mirror oscillation the movement of the body is *per se* not operative—or necessarily so, at all events—in exciting the nausea, but that the movement of the body increases the liability to sickness because it introduces further and more complex visual impression disturbances.

There is a very interesting agreement between the effects of the swing and mirror apparatus, as observed in the above experiments, and the effects observed in a ship, namely, that individuals who do not suffer at sea are found not to be affected by the conjoined swing and mirror disturbance. So far as the symptoms produced by the apparatus are concerned they appear to be to all intents and purposes identical with those of sea sickness, and the inference necessarily follows that these experiments indicate that visual impression disturbances constitute a very important factor in the production of sea sickness.

The parallelism between the action of the apparatus and the action of the influences in operation at sea is obvious. The movement of the apparatus produces sickness and other phenomena identical with those produced by the motion of the ship.

At sea the observer is, we will suppose, sitting on deck with his face towards the bow of the vessel, with nothing visible to the eye but the fore part of the ship and the sky. The vessel moves from before backwards—in other words, pitches and tosses with a vertical motion. To this pitching and tossing motion there is added, we will suppose, a certain amount of lateral motion—in other words, the vessel rolls as well as pitches and tosses. Now the observer, seated on the deck, and looking at the fore part of the vessel, sees the objects before him in a state of movement, which movement is a compound of a vertical movement and a lateral, the general result being an irregularly oblique motion which varies from time to time in regard to its component movements, for the rolling is not equable nor is the pitching movement equable, each of them being from time to time exaggerated. The view presented so far, resembles that producible by an oblique oscillation of the mirror, which we may term “mirror” disturbance. But the observer is subjected to other and further influences. He is himself moved as the vessel moves, sometimes in an inverse sense, at other times with the same motion. If he be seated in the centre of the vessel, the rolling motion will move him less than when he is sitting at the edge of the deck. And if he take up a position near the centre of the vessel altogether, the pitching and tossing will disturb his position much less than when he is seated, we will say, midway between the centre of the ship and the bow. If we place him midway between the centre of the ship and the bow, but at the edge of the deck, and the vessel be both pitching and tossing and rolling, he will be moved very decidedly in two directions. The result of the two movements—vertical and lateral—on him will be to produce a more or less constant oblique motion,

varying at different moments in nature and degree. His position under these circumstances resembles that of an individual placed in the swing of the apparatus before described; his body has imparted to it an oblique motion which is necessarily productive of obliquity of visual disturbance. There is produced then a double obliquity by the action of the ship, which can be closely imitated by the moving mirror and swing. It should be pointed out further that at sea, as well as in the swing, the individual has the power of to a certain degree lessening the intensity of the visual disturbances to which he is subjected by moving the head or body in such a manner as to correct some of the disturbance. Thus, if he moves the trunk a little to the left when the deck of the vessel is sinking away to the right, an upright position of the body is preserved; and so again, when the vessel pitches, if he moves the head and trunk a little backwards, this preserves a vertical position, and destroys to a certain extent what may be conveniently described as the "platform" disturbance.

The foregoing observations and remarks were recorded but not published nearly seven years ago. I had intended to make further experimental observations before publishing them, but circumstances have hitherto interfered with the carrying out of this intention.

In my earlier personal experiences of sea sickness I learned that, when the objects looked at are away from the vessel and therefore comparatively fixed—for example, the clouds, the horizon, the sea shore (if in view), or a passing vessel—when some such object could be fixedly regarded, no part of the vessel in which the voyage is made intervening, the sensation of sea sickness could be kept off even in rough weather. For moderately susceptible cases this method of preventing sickness answers extremely well; but it necessitates being on deck and so placed as to be able to look easily away from the ship. The benefit of this fixation of the eyes on some object away from the vessel is, as I have found in conversation with sufferers, not very extensively known, though recognised as a valuable resource by many. Its efficacy suggested to me the view that visual impression disturbances are largely concerned in the production of sea sickness.

Another method of preventing sea sickness, which I have practically tested and found most valuable, is that consisting in the complete abolishment of vision for the time being by bandaging the eyes, and thereby shutting out the possibility of visual disturbances. This method involves careful application of a bandage over the eyes before starting on the voyage. The plan in question answers extremely well in the large majority of cases. It is generally necessary for the patient to lie down in order to ensure proper adjustment of the bandage. Incidentally the patient under these circumstances gets the benefit of the horizontal position (an old remedy), and it may, of course, be said that if the bandage and the horizontal position be both employed, the benefit sustained is as likely to be due to the position as to the bandaging. Besides, I have known several cases where bandaging the eyes without lying down has proved to be preventive of sea sickness.

The results obtained by the experiments which have been related are such as to show that whatever else may be the cause of sea sickness, visual disturbance impressions have a great degree of importance in the etiology of this distressing

malady. In considering the question of the influence of disturbed vision in reference to sea sickness, we have at the outset to deal with the fact that sea sickness sometimes affects individuals who are completely blind, and in whom consequently there are no visual impressions at all. It is not known what is the proportion of blind people who are liable to sea sickness compared with the proportion of not blind people liable to sea sickness, but this is a point worthy of being investigated.

The co-existence, occasionally at all events, of blindness and liability to sea sickness shows of course that other disturbances besides those connected with visual impressions are capable of occasioning sea sickness. This no doubt necessitates the conclusion that in any general theory of the cause of sea sickness the visual disturbance theory cannot play an exclusive part. It may, however, be that it will occupy a very prominent one.¹ The variation in physique and in temperament is very different in different individuals. Great also is the variation in regard to liability to sea sickness. It is probably the case that in the majority of cases of "liable" people the prevention of visual disturbance by visual fixation or by temporary abolition of vision, will be found practicable. Also, that in a small percentage of the "liable" people the abolition of visual action will not prove sufficient to prevent occurrence of sea sickness.

I forbear at this moment from discussing other explanations of the occurrence of sea sickness.

¹ The following experience is interesting as an illustration: Observation in the cabin of a Channel boat, about the year 1883. Weather stormy, sea very rough, passage from Boulogne to Folkestone. A lady, her child about 1½ year old, and the nurse, took food freely at the table in the cabin before the vessel left Boulogne; as soon as the vessel had crossed the bar the motion was very great, and very shortly all three of the party became violently sick, and the child distressingly so, crying and exclaiming in a great state of alarm. The mother had the child seated on her lap, and had difficulty in holding it on account of her own severe sickness. After a time she tried to compose the child, and succeeded in a little while by holding the child with its face hidden against her own chest. It was noticeable that in about a quarter of an hour the child ceased to be sick and was quiet, and this state of improvement persisted for some minutes. After a while, however, the child feeling well, sat up and looked about in a cheerful manner, the mother and the nurse continuing to be sick without relief. After the child had been looking around for a short time the sickness returned, and the vociferation and cries of distress returned as badly as before. Again the mother pressed the child to her breast, and the same result as before was observed, namely, a quieting and final disappearance of the sickness, so long as the child remained with its face compressed against the mother's dress. Again there was a lull in the symptoms for a quarter of an hour or thereabouts. The child again feeling lively and well sat up and resumed its lively observation of all that was going on. A third time the catastrophe followed, and violent and severe sickness occurred. It was again quieted in the same way. By the time that we reached Folkestone the child had had four distinct illnesses and recoveries. The mother and the nurse were continuously ill the whole of the time.